REMARKS

Claims 1-10 and 12-33 are pending in this application. Claim 11 has been canceled and claim 1 has been amended to incorporate the limitations of former claim 11. Claims 32 and 33 have been amended to replace "CDO" with carbon doped oxide.

Claim Objections

Claims 32 and 33 were objected to as containing informalities. Applicants have amended these claims to comport with the Examiner's request.

35 U.S.C. § 103 Rejections

Claims 1-16 and 18-32 have been rejected under 35 U.S.C. § 103 as being unpatentable over U.S. Patent Publication No. 2006/0110931 to Fukazawa ("Fukazawa"). Claims 17 and 33 have been rejected as being unpatentable over the combination of Fukuzawa and U.S. Patent No. 7,087,271 to Rhee et al. ("Rhee").

Applicants have amended claim 1 to recite that the carbon doped oxide layer has a dielectric constant of 3 or less. The distinction between oxide layers and carbide layers is important. Silicon carbide films (Si-C based, including oxygen doped Si-C, films) are harder and so are used as diffusion barriers and etch stops but have higher dielectric constants. Carbon doped silicon oxide films (Si-O based films), used for interlayer dielectrics, have lower k values but have inferior mechanical properties.

Prior to Applicants' invention, low k films (k<3.2), including CDO films, had a tensile stress in excess of 50MPa. The residual stress of CDO films produced under unoptimized process conditions is generally >50 MPa with a typical value in the range between 60MPa and 90MPa. Embodiments of the invention significantly lower residual film stress by appropriate precursor selection and optimizing deposition process conditions.

Neither Fukuzawa, nor Rhee, teach or suggest a film that has both low dielectric constant and low stress. As discussed in Applicants' specification, the processes of this invention significantly lower residual film stress by appropriate precursor selection and/or optimizing deposition process conditions. Prior to Applicants' invention, carbon doped oxide layers were not able to have low-k and low tensile stress.

Applicants maintain their argument that Fukuzawa relates to carbides and not oxides. Throughout Fukuzawa, it is clear that the films are Si-C based. The Examiner points to

paragraph [0026] of Fukuzawa as "SiCOH films, wherein the silicon has an O- terminal" as showing that the films of Fukuzawa are silicon oxide films. This statement must be read in the context of the rest of the application: Fukuzawa states that "herein 'silicon carbide' includes pure SiC and non-pure SiC such as SiCOH" (paragraph 0019). As is understood, oxygen doped carbides will have some Si-O groups. The fundamental structure remains Si-C – allowing the film to be used as a hard film. It is clear from the entirety of the application that the films produced by Fukuzawa are carbides.

Even if, for the sake of discussion, Fukuzawa describes the deposition of oxide films, Applicants note that Fukuzawa has a filing date of December 5, 2006 that falls after Applicants' filing date of April 7, 2005. If the Examiner is relying on an earlier filing date, Applicants respectfully request that that the specific sections of the earlier reference that properly support the subject matter relied upon to make the rejection are cited.

Applicants have reviewed the parent application: Application No. 10/412,363 to Hyodo, now Patent No. 7,064,088 ("Hyodo"). Applicants submit that the deposition of CDO films having low dielectric constant and low stress is not supported by Hyodo. Specifically, Applicants submit that Hyodo describes deposition of two types of films: "insulation films" having a fundamental Si-O structure (cols. 4-12) and "hard films," i.e., Si-C structures (cols. 13-19). Nowhere does Hyodo teach or suggest deposition of any film having both low dielectric constant and low stress.

In Hyodo, insulation films are described as having dielectric constants below 3.0. There is no teaching or suggestion that these films would have low stress. It appears that these films are conventional low-k films having stress above 50 MPa. Hard films in Hyodo are described as having lower stress of about 0 to about 300 MPa, but higher dielectric constants.

In short, even without regard to the question of whether the deposited films are oxides or carbides, neither Hyodo nor any cited reference teaches or suggests deposition of a film having both a dielectric constant of 3.0 or less and a stress of less than 50 MPa in magnitude.

Applicants also note that claim 32 specifies that the CDO layer is an ILD layer. The Examiner has rejected the claim as obvious over Fukuzawa but has not cited any sections of the reference. As discussed in Applicants' previous amendment, the films of Fukuzawa are used as barriers to prevent copper from diffusing into ILD layers and/or etch stop layers in damascene patterning of ILD layers. There is no teaching or suggestion that they would be appropriate for use as an ILD. Applicants respectfully request that the Examiner identify the sections of the reference relied upon to make the rejection.

For at least these reasons, Applicants submit that claims 1 and 19, as well as their dependent claims are patentable over the cited art and request that the rejections be withdrawn.

Conclusion

Applicants believe that all pending claims are allowable and respectfully request a Notice of Allowance for this application from the Examiner. Should the Examiner believe that a telephone conference would expedite the prosecution of this application, the undersigned can be reached at the telephone number set out below. If it is determined that any additional fees are due, the Commissioner is hereby authorized to charge such fees to Deposit Account 500388 (Order No. NOVLP091).

Respectfully submitted,
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